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Investigation of impurities and laser induced damage in rapidly grown KDP

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Abstract

Impurities and their interaction with intense laser light are both of fundamental interest in material defect physics and of practical importance in laser fusion applications. Here we present the results of investigations into the distribution of impurities in rapidly grown crystals of KDP and their role in laser induced damage. Impurity levels were measured using optical spectroscopy and mass-spectroscopy. We have classified the impurities in the bulk according to the dependence of their concentrations on crystal growth conditions. The variations in impurity levels are shown to lead to optical inhomogeneities as well as low thresholds for laser damage at the sector boundaries. However, following thermal annealing, the damage threshold of the boundaries and optical performance becomes equal to that of the surrounding material suggesting that stresses at the interface generated by these impurity differences are relieved by thermal annealing. Fluorescence images by UV laser excitation were used to locate the impurities in the crystal at sub-damage-threshold fluences. Photoemission images and spectra were then collected during laser irradiation at fluences above the threshold. The photoluminescence spectra and decay lifetimes were measured in order to probe electronic trap states and their association with laser induced damage.

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